SOLAR SHINGLES AND TILES –

Where Solar Technology and Roofing Meet

By Filipp Eretnev

Photo 1 – Home sporting Dow's Powerhouse Solar Shingle system.

Have you ever thought that solar technology was a new concept? Its history actually spans over two millennia, from the 7th century BC to the present. Man started out concentrating the sun's energy with glass and mirrors to light fires. Today, with the advances in technology and demand for renewable energy, the world's architects, builders, consultants, and other science professionals have been collaborating to imagine and birth everything from solar-powered buildings to solar-powered cars. As Thomas Edison stated in 1931:

> I'd put my money on the sun and solar energy. What a source of power! I hope we don't have to wait until oil and coal run out before we tackle that.

Finally, many years later, Edison's hope for solar energy is becoming a reality. Let's review the history of solar energy, see how far solar has come, and then discuss how we as roofing professionals can influence and inspire our world by promoting applications of solar technology in an effort to help solve our ongoing energy problem. A solar-powered earth can become a reality starting with how we power our structures, and this can be achieved by continuing to use such technologies as solar-powered shingles (*Photo 1*).

HISTORY OF THE USE OF SOLAR ENERGY

The first cultures to record the use of solar energy were the Chinese, Greeks, and Romans. In 20 AD, the Chinese documented the use of mirrors to light torches for religious ceremonies. The Roman bathhouses of the 1st century AD and the 13th-century cliff dwellings of the North American Pueblo people faced the south for optimal sun energy.

Skipping to 1767, the Swiss scientist Horace-Benedict de Saussure was credited with building the world's first solar collector, later used by Sir John Herschel to cook food during his South African expedition in the 1830s. In the 1860s, French mathematician Augustin Mouchet invented a

Photo 2 – A technician installs solar shingles on a roof, nailing them just like asphalt shingles (Courtesy of Dow).

solar-powered steam engine, the predecessor of the modern parabolic dish collector. In 1873, Englishman Willoughby Smith discovered the photoconductivity of the element selenium; and three years later, his fellow countrymen William Grylls Adams and Richard Evans Day discovered that selenium produces electricity when exposed to the sun. Although selenium failed to convert sufficient sunlight to power electrical equipment, they proved that a solid material could change light into electricity without heat or moving parts. With this new spark of light, the scientists of the late 1800s to the mid-1900s explored these concepts to help power the second industrial revolution.

German physicist Wilhelm Hallwachs discovered that a combination of copper and cuprous oxide was photosensitive. In 1905, Albert Einstein published a paper on the photoelectric effect and in 1921 was awarded the Nobel Prize for "discovery of the law of the photoelectric effect."

In 1954, Daryl Chapin, Gerald Pearson, and Calvin Fuller developed the silicon photovoltaic (PV) cell at Bell Labs in New Jersey. This was the first solar cell capable of converting enough solar energy to operate everyday electrical equipment. After years of experimentation, this technology has enabled us to construct megawatt buildings, planes, trains, and now roofing material. It has even enabled us to explore space via PV-powered satellites.

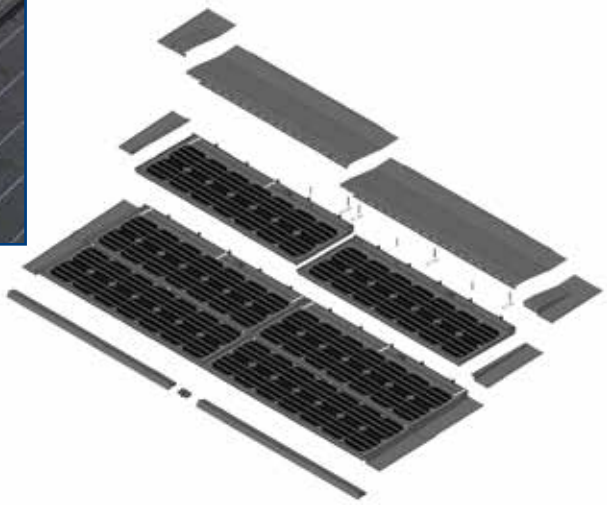
Solar cells have only been available

Photo 3 – Powerhouse shingle detail.

Photo 4 – Building-integrated PVs are less obtrusive and more visually pleasing. Dow's Powerhouse Solar Shingle was named one of the "50 Best Inventions of 2009" by Time *magazine.*

Photo 5 – Apollo II shingles on the roof. (Photo courtesy of Saint-Gobain.)

Photo 6 – The makeup of the Apollo II shingle system can be seen with its various elements. (Photo courtesy of Saint-Gobain.)



commercially since 1956. Cost of such energy, however, at about $250 to $300 per watt, was out of line with that produced by coal, costing $2 to $3 per watt.

BUT WHAT ABOUT ROOFING?

Awkward-looking, rack-mounted solar panels the size of conference tables on roofs have become ubiquitous in the ensuing decades, but aesthetics have recently pushed the market to develop a more appealing alternative: solar shingles.

It wasn't until the 1990s that Subhendu Guha's pioneering work in the field of amorphous silicon led to the development of a flexible, lightweight PV panel that could take the place of asphalt shingles.

Since then, the race has been on. It took some time to achieve a higher rate of electrical conversion in order to make shingles commercially viable in comparison with separate panels. On the market since 2005, the solar shingle has developed and become widely available and more affordable.

The new systems use building-integrated photovoltaics (BIPV) and combine cells—also known as thin film—with metal, slate, fiber-cement, and asphalt roofing.

Two of the leaders in solar shingles are CertainTeed, with the Apollo line, and DOW Chemical Company, with its Powerhouse line.

DOW offers a thin-film solar product made from flexible copper indium gallium diselenide (CIGS). The electrical circuitry is integrated into each shingle. The product touts ease of installation, with no on-roof wiring required. The array nails directly to the roof deck, just like a traditional asphalt roof (*Photo 2*). The shingles have a "reveal height" of 10 in., a reveal width of 22.8 in.,

and a ½-in. thickness (*Photo 3*). They are wireless and snap together. Once installation is completed, a certified electrician connects the system to the solar inverter, which converts direct current (DC) into alternating current (AC) to power the home.

The ability to use these systems over existing metal or asphalt shingles is basically like placing a large sticker directly on the roof. Wires are then connected to the thin-film PV, daisy-chained together, connected to the inverter and battery backup system, and tied to the existing electrical grid. Dow states that a typical cluster of 350 solar shingles can cut a homeowner's electric costs by 40-60% (*Photo 4*).

CertainTeed's Apollo line offers both a shingle "module" and a concrete tile. It uses a grid-tied monocrystalline sil-

Photo 7 – The Apollo II shingle is integrated with CertainTeed's LandMark Solaris shingles on the GridSTAR New Zero Energy Demonstration Structure in Philadelphia. (Photo courtesy of Saint-Gobain.)

Photo 8 – The Apollo II tile is integrated with flat concrete products. (Photo courtesy of Saint-Gobain.)

icon technology that offers efficiency and price similar to larger bolt-on arrays but with less bulk. Each Apollo II shingle module weighs only 12 pounds—about as heavy per square foot as typical asphalt shingles. They are nailed directly to the deck (*Photos 5, 6,* and *7*).

CertainTeed's Apollo II tiles (*Photo 8*) claim to produce 13 watts of power per square foot and are designed to integrate with shingles and flat concrete-roof products without the need for rack mounting or structural reinforcement. CertainTeed's power statement is similar to Dow's, claiming electric cost savings of 40-70%.

These solar savings vary by geographical location and directional orientation, as well as individual surroundings and meteorological circumstances. Some larger cities will have a better rebate and savings program versus some rural areas. Solar shingles should be installed by certified and authorized roofing contractors.

In addition to the more attractive, flush look these products achieve, they have passed the standard safety, durability, and performance tests.

While effectiveness and cost benefits vary widely, and power companies are beginning to balk over the concept of net metering buy-back power arrangements, at this time it is estimated that for every dollar invested in a solar shingle roof, the owner can potentially realize up to $4 back in energy savings over a 20-year period.

We as a society have come a long way since the 7th century BC in understanding how to harness the sun's energy to better our standard of living. Solar technology will continue to evolve; and manufacturers, architects, builders, and other industry professionals will increasingly adopt the great benefits solar technology can offer to the built environment.

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